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THE WORK OF THE UMATILLA RECLAMATION PROJECT EXPERIMENT FARM IN 1917

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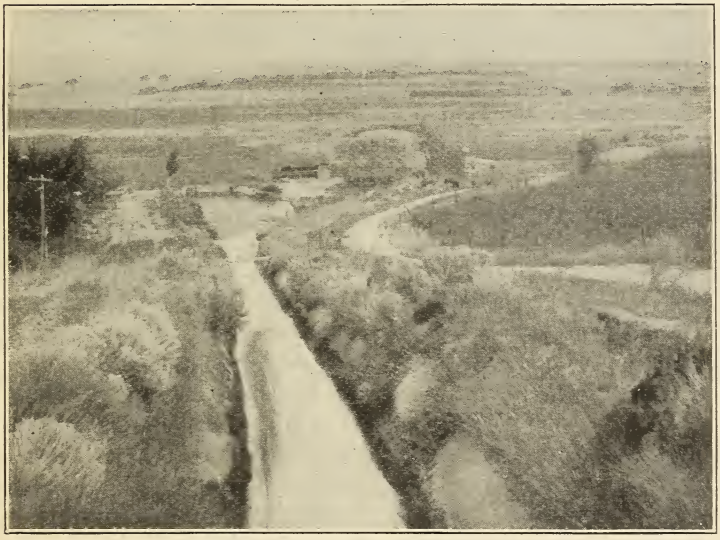

Scene on the Umatilla Reclamation Project

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THE UMATILLA EXPERIMENT FARM is located on the Umatilla Reclamation Project, about 2 miles north of Hermiston, Oreg. The farm contains 40 acres of land withdrawn from entry in 1908 by the Department of the Interior for use as an experiment farm.

It is maintained and operated by the Oregon Agricultural Experiment Station in cooperation with the Bureau of Plant Industry, United States Department of Agriculture, under a cooperative agreement.

Operations were begun in 1909. The buildings used were constructed by the United States Reclamation Service and by the Oregon Agricultural Experiment Station.

The expenses of the farm are shared equally by the Oregon station and the Office of Western Irrigation Agriculture.

The investigational work is under the immediate supervision of a farm superintendent, who is a collaborator of the Bureau of Plant Industry.

THE WORK OF THE UMATILLA RECLAMATION PROJECT EXPERIMENT FARM IN 1917.

CONTENTS.

THE PROGRESS OF AGRICULTURAL DEVELOPMENT.

THE SANDY SOIL of the Umatilla Reclamation Project has been difficult to bring into profitable production because it has been deficient in organic matter, easily eroded by the wind and by irrigation streams, and very porous, so that the irrigation water percolates rapidly.

The investigations on the Umatilla Experiment Farm have been directed to soil-improvement work, in which commercial fertilizers, green-manure crops, and crop-rotation methods are employed. Particular attention has also been given to irrigation studies looking to the development of methods that will permit more economical use of irrigation water and experiments to determine the frequency of irrigation necessary for the best results without unnecessary loss of water. The earlier progress of this work has been shown in previous reports.[1] Some attention has also been given to the design of ditch structures, such as check gates and turnout boxes.

Variety tests of fruit trees and grapes were also conducted and notes made on the performance of ornamental plants and windbreak trees. A number of the varieties of fruit trees bore in 1917, and observations were made of their character and the quality of the fruit.

[1] See Allen, R. W., "The Work of the Umatilla Experiment Farm in 1912," United States Department of Agriculture, Bureau of Plant Industry Circular 129, pp. 21–32, 1913; also "The Work of the Umatilla Reclamation Project Experiment Farm in 1913," an unnumbered circular of the Office of Western Irrigation Agriculture of the United States Department of Agriculture, issued August 25, 1914; "The Work of the Umatilla Reclamation Project Experiment Farm in 1914," Western Irrigation Agriculture Circular 1, United States Department of Agriculture, issued June 18, 1915; and "The Work of the Umatilla Reclamation Project Experiment Farm in 1915 and 1916," Western Irrigation Agriculture Circular 17, issued November 24, 1917.

CONDITIONS ON THE PROJECT.

CLIMATIC CONDITIONS.

The crop season was relatively favorable to crop production. Table I summarizes the weather observations for the 6-year period from 1912 to 1917. Cool spring weather held the fruit back until danger of frost had passed, the result being that the blossoms were not injured, and a good crop was produced.

TABLE I.—*Summary of climatological observations at the Umatilla Experiment Farm, 1912 to 1917, inclusive.*

PRECIPITATION (INCHES).

Year, etc.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Average for 5 years, 1912 to 1916	1.57	1.04	0.66	0.74	1.08	0.82	0.34	0.37	0.18	0.66	1.00	0.75
1917	.55	1.01	.22	1.13	1.20	.29	0	0	.38	0	1.02	2.06

EVAPORATION (INCHES).

Average for 5 years, 1912 to 1917	------	------	------	4.0	5.59	7.15	8.42	6.67	4.48	2.35	------	------
1917	------	------	------	4.056	5.354	7.918	8.918	6.607	4.057	3.059	------	------

DAILY WIND VELOCITY (MILES PER HOUR).

Highest, 1912 to 1916	15.3	13.0	16.9	15.7	11.8	14.5	12.1	13.7	11.1	12.3	13.4	15.4
1917	32.6	7.3	15.8	9.8	8.0	8.9	9.9	6.4	8.4	10.7	3.0	12.0
Lowest, 1912 to 1916	.2	.5	.1	.6	.5	.9	.9	.3	.2	.1	.1	.1
1917	0	.3	.8	1.5	.8	.6	.8	.4	.4	.4	.3	.3
Mean, 1912 to 1916	2.7	2.9	3.7	3.8	3.8	4.8	4.2	3.1	2.9	2.5	2.1	2.3
1917	4.3	2.4	6.0	4.6	3.1	4.1	3.0	1.9	2.2	2.6	1.0	4.0

TEMPERATURE (° F.).

Absolute maximum, 1912 to 1916	66	64	74	86	91	104	105	104	93	81	66	63
1917	57	62	66	71	82	97	106	103	92	85	67	70
Absolute minimum, 1912 to 1916	−27	− 6	15	26	29	35	44	39	29	17	3	− 4
1917	1	4	6	27	31	40	39	43	34	17	16	21
Mean, 1912 to 1916	29	34	45	53	59	66	72	74	62	51	40	31
1917	32	36	40	50	57	65	75	73	65	53	43	44

TABLE II.—*Killing frosts at Hermiston, Oreg., 1909 to 1917, inclusive.*

Year.	Last in spring.		First in autumn.		Frost-free period.
	Date.	Minimum temperature.	Date.	Minimum temperature.	
		°F.		°F.	*Days.*
1909	Apr. 21	27	Oct. 16	30	178
1910	Apr. 30	27	Oct. 15	31	168
1911	Apr. 20	31	Sept. 23	26	156
1912	Apr. 16	31	Oct. 6	31	173
1913	Apr. 23	28	Sept. 24	31	154
1914	Apr. 29	30	Oct. 20	31	174
1915	May 2	31	Oct. 5	30	156
1916	May 14	31	Sept. 28	29	138
1917	May 2	31	Oct. 17	22	168
Average	------	------	------	------	162

Table II shows the dates of occurrence of killing frosts from 1909 to 1917, inclusive, at Hermiston, Oreg., near the Umatilla Experiment Farm. The summer was favorable for the growth of alfalfa and most other crops, as it was long, dry, and warm. A large yield of first-class hay was harvested. The dry weather continued into early winter and threatened damage to fall-sown crops of vetch and young alfalfa, but rain came before serious loss occurred.

The early winter was exceptionally mild and favored the growth of fall-sown crops and late pasture. Much more land was cleared and sown to alfalfa than in any previous year.

AGRICULTURAL CONDITIONS.

Although the spring appeared to be unfavorable on account of the cool season, most crops started promptly and made a good growth when settled weather came. The yield and quality of the crops were unusually good.

A notable feature of this crop year was the almost total absence of injurious effects from rabbits and insect pests other than the codling moth. Many apples were destroyed as a result of inadequate or improper spraying. The crop of fruit otherwise was of very good quality. Thirteen cars of apples were shipped out, in addition to a large quantity sold locally. Eight cars of peaches were sold in bulk to commercial processors at The Dalles, Oreg. The opening of this market was very favorable for the peach growers, since it permitted them to get good prices for their products without the expense involved in wrapping and crating the fruit. The size and quality of the peaches were unusually good.

A total of 76,296 pounds of butter fat was purchased from project farmers by the local creamery at an average price of 44 cents a pound. This indicates a decided increase in yield over last year.

The swine industry has experienced a decline of about 50 per cent, due chiefly to the high price of grain, of which very little is produced on the project. The sale of hogs in car lots in 1916 amounted to 12 cars, worth approximately $18,000. In 1917 six cars of hogs were shipped and sold at prices practically double those received in 1916.

The production of hay was larger than in 1916 by 3,425 tons, which is a greater increase than occurred in the previous year. The quantity sold to be fed on the project was about the same as in 1916. The remainder was baled or chopped and shipped out. During the year, 102 cars of the 1916 crop and 299 cars of the 1917 crop were shipped out, in addition to several cars sent from Umatilla. Less hay was held on farms on January 1, 1918, than a year ago.

Table III shows the acreage, yields, and farm values of crops produced on the Umatilla Reclamation Project in 1917, according to reports gathered by the United States Reclamation Service. The

beginning of activities on the western extension of the Umatilla project is responsible for a considerable increase in the acreage of crops.

TABLE III.—*Acreage, yields, and farm values of crops produced on the Umatilla Reclamation Project in 1917.*

Crop.	Area (acres).	Unit of yield.	Yield.			Farm value.		
			Total.	Per acre.		Per unit of yield.	Total.	Average per acre.
				Average.	Maximum.			
Alfalfa	4,047	Ton	14,834	3.7	6.7	$15.366	$227,940	$56.32
Alfalfa seed	83	Bushel	256	3.1	10	10.25	2,625	31.63
Apples	342	Pound	772,717	2,259.4	12,000	.0176	13,630	39.86
Barley	4	Bushel	48	12	12	1.20	60	15.00
Beans	4	do	21	5.2	12	7.71	160	40.00
Corn (Indian)	130	do	3,799	29.2	100	1.946	7,395	56.89
Corn (fodder)	110	Ton	571	5.2	10.8	8.109	4,630	42.09
Fruits (small)	49						4,205	85.82
Garden	50						6,660	133.20
Hay	221	Ton	195	.9	2.5	13.164	2,565	11.61
Millet seed	3	Bushel	15	5	5	6.667	100	33.33
Onions	2	do	226	112		1.429	325	162.50
Pasture	1,293						15,895	12.29
Peaches	160	Pound	438,834	2,742.7	12,000	.0134	5,895	36.84
Pears	10	do	22,100	2,210	9,600	.0345	760	76.00
Potatoes (white)	106	Bushel	10,311	97.3	600	1.133	11,680	110.19
Wheat	9	do	150	16.7	30	2.10	315	35.00
Watermelons	11						650	59.09
Miscellaneous	77						5,905	76.66
Total	5,546						311,395	
Average								56.15

The increase in the number of live stock is shown in Table IV, furnished by the United States Reclamation Service. The large increase in the number of live stock is principally due to the settlement of the western extension, which is well under way. The increase in the value of live stock, which is relatively greater than the increase in number, is entirely due to the rise in the price of animals.

TABLE IV.—*Number and value of live stock on the Umatilla Reclamation Project on January 1 and December 31, 1917.*

Item.	Inventory, Jan. 1.			Inventory, Dec. 31.			Increase or decrease in total value.
	Number.	Value.	Total value.	Number.	Value.	Total value.	
Horses	571	$90.93	$51,921	723	$99.71	$72,090	$20,169
Mules	39	111.28	4,340	30	145.00	4,350	10
Cattle:							
Dairy	737	52.74	38,870	1,008	60.83	61,320	22,450
Beef	46	42.72	1,965	70	34.00	2,380	415
Sheep	4,581	8.03	36,785	4,372	15.895	69,495	32,710
Hogs	929	9.73	9,039	1,411	19.22	27,119	18,080
Angora goats	50	5.00	250				−250
Fowls	10,177	.739	7,521	12,350	.794	9,805	2,284
Bees (hives)	1,210	5.00	6,050	2,401	4.97	11,930	5,880
Total			156,741			258,485	101,744

The greatest increase is found in dairy cattle and hives of bees. This increase in dairy stock emphasizes the confidence of the settlers in the dairy industry. The increase in hives of bees, which amounts to 100 per cent, is largely due to the stimulus given this industry by the unusually good honey flow in 1916.

Table V shows the increase in the number of farms, the crop acreage, and the values of the crops and of live stock for the 6-year period from 1912 to 1917. The total value of crops and live stock advanced rather uniformly until 1917, when an unusually rapid advance occurred.

TABLE V.—*Statistical summary of farms, farm crops, and live stock on the Umatilla Reclamation Project for the 6-year period from 1912 to 1917.*

Item.	1912	1913	1914	1915	1916	1917
Number of farms operated	295	311	311	306	320	411
Area cropped ..... acres..	3,218	3,033	3,013	3,678	3,900	5,546
Value of crops:						
Per acre	$24.00	$27.72	$29.41	$29.04	$35.84	$56.15
Total	77,219.00	84,078.00	88,613.00	104,653.00	139,791.00	311,395.00
Total value of live stock	77,420.00	157,500.00	136,563.00	138,522.00	156,741.00	258,485.00

Including the settlement that has taken place within the present year on the western extension of the project, 411 farms are now in operation. These farms have a total area of 13,030 acres, of which 7,327 acres were irrigated, and crops were harvested from 5,546 acres. The 1,781 acres irrigated and not harvested represent newly planted orchards and alfalfa fields.

INSECT PESTS.

The damage resulting from insect pests was less important than in several previous years. Grasshoppers and the green aphis did no appreciable damage. The work of the peach-twig miner was of little consequence. The most serious pest of the season was the codling moth, which destroyed many apples in some orchards. This was largely due to inadequate or improper spraying. The woolly aphis has made its appearance in a number of orchards, and the apple-tree leaf roller was also observed in two orchards near the station. The presence of these two insects will probably render slight changes and some additions necessary in the spraying schedule.

INVESTIGATIONAL WORK OF THE EXPERIMENT FARM.

The three principal lines of investigational work conducted on the Umatilla Experiment Farm are experiments planned to develop effective means of (1) soil improvement, (2) increasing the efficiency of irrigation water, and (3) determining the comparative value of numerous varieties of fruit and field crops.

The soil-improvement work was continued during this year without change from that outlined in the last annual report. The

investigations relating to the duty of water were broadened by the addition of four lysimeters, each of which contains a different type of soil; by starting an experiment on the width of borders for irrigating alfalfa; by irrigating the sidehill land in field C2 by flooding it down the greatest slope from contour ditches; and by preparing fields D1, D4, and a part of C2 to be irrigated by means of borders. (See fig. 1.)

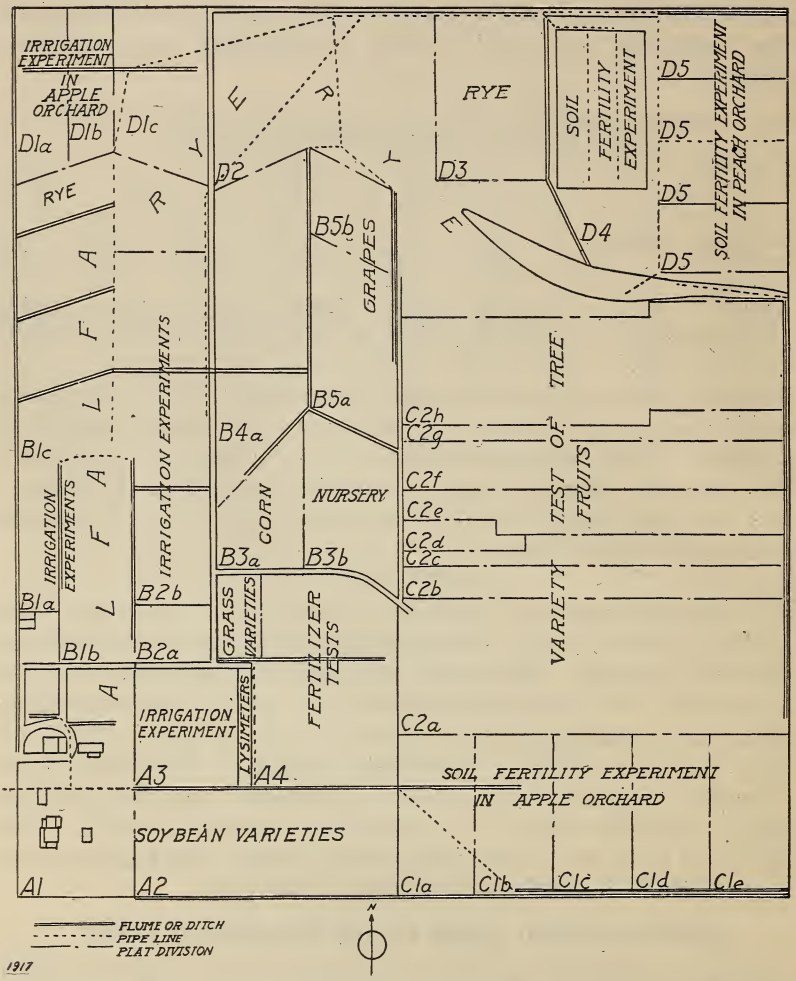

FIG. 1.—Diagram of the Umatilla Experiment Farm, showing the arrangement of the fields and the location of the experiments in 1917.

Many of the varieties of apples, prunes, peaches, and minor fruits bore fruit, which gave opportunity for noting the local expression of varietal characters. Several varieties of soy beans and pasture grasses were planted; also some Navajo corn and peppermint. A few cooperative tests of field crops were conducted.

SOIL IMPROVEMENT.

The open character of the soils of the Umatilla project makes it necessary to use large quantities of organic matter to increase the yields of crops; also to increase their capacity to retain moisture. Experiments are in progress to determine the best means of accomplishing the desired results by the use of commercial fertilizers, green-manure crops, farm manure, and systems of crop rotation.

COMMERCIAL FERTILIZERS.

The results of the year's work with commercial fertilizers on 17 tenth-acre plats in field A4 were very similar to those previously obtained. These results as expressed in crop yields with corn are shown in Table VI, comparison being made with the crop in 1913, since which time one cycle of the rotation of crops has taken place. The fertilizers in the quantity specified in this table have been applied each year to each plat.

TABLE VI.—*Comparison of the yields of corn in the experiments with commercial fertilizers in field A4 on the Umatilla Experiment Farm in 1913 and 1917.*

Plat.	Kind and quantity of fertilizer applied.	Plat yield (pounds).		Acre yield (tons).	
		Field-cured corn, 1917.	Cured fodder, 1913.	Field-cured corn, 1917.	Cured fodder, 1913.
No. 1	Nitrate of soda, 10 pounds	760	553	3.8	2.76
No. 2	Nitrate of soda, 25 pounds	790	629	3.95	3.14
No. 3	Muriate of potash, 15 pounds	690	471	3.45	2.35
No. 4	Muriate of potash, 30 pounds	680	516	3.4	2.58
No. 5	Acid phosphate, 15 pounds	700	340	3.5	1.7
No. 6	Acid phosphate, 30 pounds	900	500	4.5	2.5
No. 7	Land plaster, 5 pounds	950	603	4.75	3.0
No. 8	Land plaster, 15 pounds	840	862	4.2	4.31
No. 9	Tankage, 100 pounds	974	1,095	4.87	5.47
No. 10	Tankage, 200 pounds	1,192	942	5.96	4.71
No. 11	Blood meal, 30 pounds	[a] 710	[a] 415	3.55	2.07
No. 12	Blood meal, 60 pounds	1,530	616	7.65	3.08
No. 13	Nitrate of soda, 10 pounds; potash, 15 pounds; phosphate, 10 pounds.	1,046	511	5.23	2.55
No. 14	Same as No. 13 plus 20 pounds of lime	736	396	3.68	1.98
No. 15	Barnyard manure, 1 load	900	415	4.5	2.07
No. 16	Barnyard manure, 2 loads	1,104	444	5.5	2.22
No. 17	No fertilizer; annual vetch crop	630	.....	3.15	.....

[a] Influenced by locust-tree windbreak.

COVER CROPS AND ALFALFA IN THE APPLE ORCHARD.

The experiments with cover crops and alfalfa in the apple orchard comprise five plats located in field C1. The treatment given the plats is as follows:

Plat A.—Winter crop of vetch plowed under for green manure and followed by a cultivated crop. Corn has been used as the following cultivated crop.

Plat B.—Winter crop of vetch plowed under for green manure, followed by a summer leguminous crop to be used for the same purpose. No summer crop has been grown during the past three years.

Plat C.—Winter crop of rye plowed under for green manure, followed by clean tillage during the summer. Some manure has been applied to this plat.

Plat D.—Strips of alfalfa between the tree rows. The hay is removed and the land along the rows of trees cultivated to keep down weeds.

Plat E.—Solid stand of alfalfa from which the hay is removed.

Each plat contains approximately three-fourths of an acre and includes 32 trees, 8 each of the following varieties: Winesap, Jonathan, Rome Beauty, and Esopus (*Spitzenberg*). A heavy crop of rye and vetch was plowed under in plats A and B on May 23. The rye on plat C was plowed under on May 8.

TABLE VII.—*Apple varieties on plats receiving different cultural treatment on the Umatilla Experiment Farm, showing the yield of fruit in 1917 and the sizes of the trees in 1915 and 1917.*

Plat and variety.	Yield in 1917 (pounds).	Average size of trees (feet).			
		Spread.		Height.	
		1915	1917	1915	1917
Plat A.:					
Winesap	80	9.7	11.7	10.0	10.2
Jonathan	183	7.7	10.2	8.7	7.9
Rome Beauty	128	9.6	7.7	7.4	9.3
Esopus	75	10.6	10.2	11.2	9.6
Plat B:					
Winesap	161	11.2	13.8	11.4	11.8
Jonathan	192	9.2	11.3	9.7	8.3
Rome Beauty	15	5.7	6.5	8.4	8.1
Esopus	32	8.1	8.1	9.0	7.7
Plat C:					
Winesap	79	10.0	11.8	9.8	10.7
Jonathan	61	6.0	7.1	5.8	6.1
Rome Beauty	45	4.5	5.4	6.5	7.6
Esopus	28	8.2	8.9	9.4	8.3
Plat D:					
Winesap	4	6.7	6.7	5.5	7.9
Jonathan	20	6.2	6.5	5.5	5.8
Rome Beauty	.....	3.4	4.3	6.5	7.0
Esopus	.....	8.6	8.3	8.7	8.2
Plat E:					
Winesap	4	6.7	5.3	4.1	8.4
Jonathan	.....	3.3	3.5	2.9	4.9
Rome Beauty	.....	4.0	2.0	1.5	4.2
Esopus	.....	2.6	3.0	4.4	6.0
All four varieties:					
Plat A	469	9.4	9.9	9.3	9.3
Plat B	400	8.5	8.9	9.6	10.0
Plat C	213	7.2	8.2	7.9	5.3
Plat D	24	6.2	6.5	5.4	7.8
Plat E	4	4.1	3.5	3.2	5.9

The yield of fruit, as shown in Table VII, varies greatly for the different plats. The treatment given plat A appears to be more satisfactory than the others, as the yield is larger. However, the average size of trees is approximately the same as those on plat B. The yield of fruit and size of trees on plat C is decidedly less than on the first two plats. This is partly due to a portion of this land being heavily graded, upon which some of the trees have not done well. The trees in plat D, with alfalfa between the rows, have done much better than those in plat E, where there is a solid stand of alfalfa. This appears to be a fair example of the comparative success met with in starting trees with a strip of alfalfa between them and with a solid stand of alfalfa. In the latter case the trees appear to have had very little chance to succeed. This does not indicate, however, that alfalfa can not be sown in mature orchards without inflicting damage to the trees, for it appears that mature trees can compete successfully with alfalfa where immature ones are unable to do so. The

size of trees in plats A, B, and C has increased very little during the past two years, although they appear to have done well. They have been well cared for and maintain a thrifty appearance.

RAW LAND COMPARED WITH ALFALFA SOD FOR STARTING AN ORCHARD.

The peach-orchard experiment located in field D5 has been continued as outlined in the 1916 report. Plats A and B were planted in 1911 on raw land and C and D were planted in 1914 on land that had been in alfalfa for two years. Vetch is now being grown on plats A and C, and plats B and D are kept in an annual crop of rye. Both crops are left standing until fall, when they are worked into the ground to reseed it. The crop of vetch is rather thin from winterkilling, which was caused by drought. The first blossoms of the varieties on this plat occurred as follows in 1915: Alexander, April 2; Early Crawford and Elberta, March 29; Triumph, March 28. In 1917 they appeared as follows: Alexander and Early Crawford, April 19; Elberta, April 20; Triumph, April 18. In 1915 the fruit began to mature as follows: Alexander, June 25; Early Crawford, August 13; Elberta, August 15; Triumph, July 5. Fruit matured in 1917 as follows: Alexander, July 27; Early Crawford, September 6; Elberta, September 12; Triumph, August 3. The very marked difference in the season of maturity of the fruit in 1915 and 1917 was influenced by the early season of 1915 and the unusually late season of 1917. The yield of fruit in 1915 was very light. The 1917 crop was also light, as shown in Table VIII.

TABLE VIII.—*Peach varieties on raw land compared with those on alfalfa sod on the Umatilla Experiment Farm, showing the yield of fruit in 1917 and the sizes of trees in 1915 and 1917.*

Plat and variety.[1]	Yield per plat in 1917 (pounds).	Average size of trees (feet).			
		Spread.		Height.	
		1915	1917	1915	1917
Plat A [1]:					
Alexander	101	5.9	6.3	7.8	6.2
Early Crawford	20	5.2	5.7	5.6	6.0
Elberta	9	5.4	5.6	5.9	5.7
Triumph	115	7.5	7.6	8.5	7.6
Plat B:					
Alexander	320	8.2	10.7	11.5	8.3
Early Crawford	131	7.7	8.3	8.5	8.2
Elberta	20	8.0	7.7	8.7	7.0
Triumph	124	8.8	7.4	8.5	9.1
Plat C:					
Alexander	46	5.6	6.0	5.7	5.9
Early Crawford	30	6.0	6.0	6.3	5.8
Elberta	2	6.2	6.3	6.1	6.3
Triumph	90	7.5	6.9	6.7	7.4
Plat D:					
Alexander	43	5.2	5.4	5.4	5.2
Early Crawford	36	6.1	6.0	6.0	6.2
Elberta	6	5.5	6.0	5.0	6.3
Triumph	65	7.0	6.3	6.6	7.1
All four varieties:					
Plat A	245	6.0	6.3	6.9	6.4
Plat B	595	8.2	8.5	9.2	7.9
Plat C	168	6.3	6.3	6.2	6.4
Plat D	150	5.9	6.0	5.7	6.2

[1] There are 10 trees of each variety in plat A and 8 in each of the other plats.

The average sizes of trees for the different varieties in each plat are shown for the years 1915 and 1917 in Table VIII. The yields of fruits and sizes of trees on plat A are relatively small on account of much of this land being graded, which has hindered the proper development of the trees. The trees on plats C and D, being three years younger than the others, fruited lightly, but made a very satisfactory growth. It appears that the trees started on alfalfa sod have done better at their age than the others. It is also indicated that the presence of vetch in plat C is giving it an advantage over plat D. However, the difference in the performance of these two plats is not very marked.

CROP-ROTATION SOIL-FERTILITY EXPERIMENT.[1]

The low organic-matter and plant-food content of the soils of the Umatilla project render methods of increasing the water-holding capacity of the soil and increasing the plant food available to the crops of extreme importance. The practical methods are limited to applying barnyard manure or growing green-manure crops, or to a combination of the two practices. An experiment dealing with these methods by growing forage crops in rotation with different combinations of barnyard manure and green-manure crops has been conducted for three years. The results are measured by the behavior and yields of forage crops.

The experiment is located on 36 plats of one-fortieth acre each in field D4, which has coarse sandy soil. The following are the crop sequences: (1) Alfalfa grown continuously; (2) alfalfa grown two years, rye during the second winter, followed by feterita in the summer and rye the following winter, and then alfalfa again for two years; (3) feterita grown in the summer and rye in the winter; (4) feterita grown in the summer and hairy vetch in the winter. Each sequence has three plats with no manure, three plats receiving manure at the rate of 8 tons per acre yearly, and three plats receiving manure at the rate of 32 tons per acre yearly.

The plats were irrigated at 10-day intervals during 1917. The manure was applied in the fall of 1916. The fourth crop of alfalfa on the second-year alfalfa plats was plowed under in the fall of 1916, and a cover crop of rye was planted. The cover crops of vetch and rye were sown on the feterita plats between the feterita rows late in August, 1916.

The cool spring of 1917 held back the feterita plants considerably, but after the warm weather came they made very rapid growth. The figures given as the results are each the average of three plats.

The result of alfalfa turned under was very noticeable on the rye cover crop and on the crop of feterita which followed. The rye fol-

[1] This experiment was conducted and reported upon by Mr. H. K. Dean, scientific assistant.

lowing alfalfa made a much heavier, leafier growth and was considerably taller than that following the feterita crop, as shown in Table IX.

TABLE IX.—*Height of rye cover crop following alfalfa and feterita and yield of alfalfa on land receiving varying quantities of manure on the Umatilla Experiment Farm in 1917.*

Items of comparison.	Manure per acre on plats.		
	None.	8 tons.	32 tons.
Height of rye following alfalfa.....feet..	2.9	3.2	3.8
Height of rye following feterita.....do....	1.3	1.8	2.4
Yield of alfalfa per acre.....tons..	4.47	5.47	6.25
Increase in yield over no manure.....do....	.....	1.00	1.78
Increase per ton of manure applied.....do....	.....	.125	.55

The increased height of rye was more pronounced on the plats which had been in alfalfa but had not received manure than on those which received manure.

It will be noted that the plats having manure at the rate of 8 tons per acre increased the yield more in proportion to the manure used than the plats having manure at the rate of 32 tons per acre.

The results of growing feterita following cover crops have not shown any significant difference in the effect of rye and of vetch. On the unmanured plats a higher percentage of the plants matured heads where the feterita followed rye than where it followed vetch. The yield, weight per plant, number of mature heads per plant, and number of stalks per plant were also greater, and the feterita following vetch grew higher than that following the rye. (Table X.)

On the plats that were manured at the rate of 8 tons per acre the feterita following rye had heavier yields and more stalks per plant, while that following vetch gave a higher percentage of plants maturing heads, higher plants, heavier plants, and more mature heads per plant. On the plats having 32 tons of manure per acre the feterita following rye had heavier yields, higher plants, heavier plants, more mature heads per plant, and more stalks per plant, while the feterita following vetch had a higher percentage of plants maturing heads.

The feterita crop on the plats following alfalfa showed very material increases over that following cover crops of rye and vetch. The greatest increases were on the plats which had not received manure.

The results of feterita following alfalfa were much better than when following rye and vetch, as shown in Table X.

If the yields of feterita following rye and vetch be stated as 100, the yield of that crop following alfalfa without manure was 458, the yield following alfalfa with 8 tons of manure was 190, and the yield following alfalfa with 32 tons of manure was 128.

TABLE X.—*Growth of feterita following alfalfa compared with that following rye and vetch on land receiving varying quantities of manure on the Umatilla Experiment Farm in 1917.*

Items of comparison.	Manure per acre on plats.					
	None.		8 tons.		32 tons.	
	Alfalfa.	Average after rye and vetch.	Alfalfa.	Average after rye and vetch.	Alfalfa.	Average after rye and vetch.
Plants maturing heads.....per cent..	892	100	162	100	110	100
Yield.....do....	458	100	190	100	128	100
Height of plant.....do....	109	100	135	100	90	100
Weight per plant.....do....	529	100	214	100	159	100
Mature heads per plant.....do....	474	100	163	100	104	100
Stalks per plant.....do....	144	100	115	100	110	100

The applications of manure had a pronounced effect in increasing maturity as expressed in both the percentage of plants maturing heads and in the percentage of the total heads which matured. The next most pronounced effect was in the yield as expressed in tons per acre and weight per plant.

BORDER IRRIGATION EXPERIMENTS.

COMPARISON OF SYSTEMS.

The border or sloping-check method of irrigation has come into general use on the Umatilla project during the past two years. The system is one of the most economical in the initial preparation of the land; it requires the least grading, thus reducing the proportion of unproductive spots in the field; and it results in the highest duty of water and the minimum of time and labor required for irrigation.

An instance of the saving which can be effected by proper preparation of land is reported by the local office of the Reclamation Service. Two adjoining 10-acre tracts of alfalfa land of medium sandy soil and of practically the same topography were irrigated by the same man with the same-sized head of water. One piece was carefully laid out in borders, while the other was rough, and wild flooding was used. The irrigation results for a year are included in Table XI.

TABLE XI.—*Water used and cost of irrigating two 10-acre tracts of alfalfa on the Umatilla Reclamation Project in 1917.*

Irrigation method.	Average head.	Average application.	Irrigated per hour.	Cost per acre per application.
	Second-ft.	*Inches.*	*Acres.*	
Border	3.5	3.5	1.00	$0.125
Wild flooding	3.5	16.8	.21	.590

Proper preparation of the bordered tract resulted in the requirement of much less water and great saving in the time required for irrigation and in the cost of irrigation. Border irrigation resulted in an application of one-fourth the quantity of water that the wild flooding required, more than four times as much land being irrigated in an hour and the cost of irrigation being one-fourth of that on the wild-flooded area.

Experiments were conducted on the experiment farm in 1916 and 1917 to ascertain the best length for borders and in 1917 to ascertain the best widths of borders. In practice on the project, borders vary in length from 75 to 250 feet and in width from 20 to 50 feet.

LENGTH OF BORDER.

Three borders (respectively 100, 175, and 250 feet long and each 22 feet wide) were used in field B1*a* (see fig. 1) for the length-of-border experiment. The slope on the borders is very uniform and averages 0.93 of a foot per 100 feet of length. In 1916, irrigation water was applied each week, 21 applications being made; in 1917, water was applied once in two weeks, 11 applications being made. The average time required to irrigate each border, the total water applied during the season, and the amount per application are shown in Table XII.

TABLE XII.—*Time of application and amount of water used in length-of-border experiments on the Umatilla Experiment Farm in 1916 and 1917.*

Length of border.	Area (acre).	Average time of application (minutes).		Water applied per acre.			
				Total (acre-feet).		Average per irrigation (acre-inches).	
		1916	1917	1916	1917	1916	1917
100 feet	0.05	9.1	9.5	5.86	4.02	3.35	4.38
175 feet	.088	15.3	21.3	5.88	5.03	3.36	5.49
250 feet	.126	32.8	33.6	8.51	5.54	4.86	6.04

The depth of water per application on all borders was greater in 1917 than in 1916, probably because the soil was drier and the water would not go over the land as fast as in 1916. Too much water was applied per irrigation, so that there was probably considerable loss from percolation beyond the root zone. Much less water was used in 1917 than in 1916 because the applications were made only half as frequently.

The total applications in 1916 show that the 175-foot border was irrigated as economically as the 100-foot border. In 1917 the 100-foot border was irrigated with 1 acre-foot less water than the 175-foot border. All the borders probably could have been irrigated with less water had larger heads been used.

WIDTH OF BORDERS.

Five borders were graded and put into alfalfa in field A3 during 1917 for a width-of-border experiment. The plats are all 200 feet long. They are respectively 20, 25, 30, 35, and 40 feet wide. They were irrigated at irregular intervals throughout the season when the plants appeared to need water. It is thought that hardly enough water was applied during the season to secure the maximum growth. Table XIII shows the average time of application, the average amount of water applied at each irrigation, and the total water applied during the season.

TABLE XIII.—*Time of application and amount of water used in width-of-border experiments on the Umatilla Experiment Farm in 1917.*

Width of border.	Area.	Average time of application.	Water applied per acre.	
			Average per irrigation.	Total.
	Acres.	*Minutes.*	*Acre-inches.*	*Acre-feet.*
20 feet	0.092	12.7	3.48	3.18
25 feet	.115	19.0	3.99	3.88
30 feet	.138	25.7	4.64	4.76
35 feet	.161	25.3	4.17	4.14
40 feet	.184	33.0	4.60	4.65

The smallest average application was 3.48 acre-inches on the 20-foot border and the largest 4.64 acre-inches on the 30-foot border. The smallest amount of water which usually can be applied and which is held by the soil has been found to be about 4 acre-inches, so that the percolation losses even from the border which received the highest applications were about as small as it is practicable to obtain.

An acre of land laid out in 20-foot borders would have required 2 hours and 19 minutes to irrigate at the rate the 20-foot borders were irrigated. The 30-foot border was irrigated at the slowest rate, approximately 3 hours and 7 minutes per acre. The average time required on all five borders was at the rate of 2 hours and 44 minutes per acre.

The average head of water used was 1.56 second-feet, which was smaller than is generally recommended for the best irrigation practice on the project, but it shows that if the land is properly leveled, economical applications may be made with relatively small heads. However, the use of large heads results in a considerable saving of time in irrigation. The best irrigation practice on the project will not be secured until the irrigator has a knowledge of the quantity of water he is applying for each irrigation.

The size of borders which should be used necessarily varies with the soil, the head of water available, and the topography of the land. On land with steep slopes and on coarse soils the borders should be narrow and short. On land with ordinary slopes and on fine soils the borders may be longer and wider. The larger the head of water, the

larger and wider the borders may be made. Small streams of water should be used on abruptly sloping land and larger streams on the flatter lands.

INFLUENCE OF FREQUENCY OF IRRIGATION ON YIELDS OF ALFALFA.

In the ordinary irrigation practice of the project, the frequency of irrigations and the amounts of water used have shown considerable variation. An experiment has been conducted for four years at the experiment farm in which one plat was irrigated once in three weeks, one plat once in two weeks, and another once a week. During 1914 the plats were irrigated with such quantities of water as were considered good irrigations. The applications varied from an average of 4.69 acre-inches on the 1-week plat to 6.75 acre-inches on the 3-weeks plat. Soil-moisture determinations showed that an application of approximately 4 acre-inches could be retained by the surface 4 feet of soil, that this amount could be easily applied, and that it was sufficient to keep the alfalfa growing vigorously. In 1915 and 1916 the applications were limited to 4 inches in depth on each of the plats. In 1917 the 3-weeks plat received 5 inches per application, the 2-weeks plat 4 inches as before, and the 1-week plat 3 inches. The results were not materially altered by this variation in the amount of water per application, as is shown in Table XIV.

TABLE XIV.—*Irrigation data and yields of alfalfa hay in frequency-of-irrigation experiments on the Umatilla Experiment Farm during the 4-year period from 1914 to 1917.*

Irrigation interval and year.	Number of irrigations.	Water used.		Yield (tons).	
		Per application.	Per acre.	Per acre.	Per acre-foot of water.
Three weeks:		*Acre-inches.*	*Acre-feet.*		
1914	8	6.75	4.38	4.03	0.92
1915	7	4.00	2.33	3.50	1.50
1916	7	4.00	2.33	4.25	1.82
1917	7	5.00	2.92	4.10	1.40
Average	7	4.94	2.99	3.97	1.41
Two weeks:					
1914	12	5.26	5.26	5.31	1.02
1915	11	4.00	3.67	4.62	1.26
1916	11	4.00	3.67	6.36	1.74
1917	11	4.00	3.67	5.97	1.63
Average	11	4.31	4.08	5.57	1.41
One week:					
1914	24	4.69	9.69	5.57	.57
1915	21	4.00	7.00	5.67	.81
1916	21	4.00	7.00	6.72	.96
1917	21	3.00	5.25	5.95	1.13
Average	22	3.92	7.23	5.98	.87

The yields on the 3-weeks plat have not justified such frequency of irrigation. The yields on this plat have been largest per acre-foot of water, but by the use of 50 per cent more water, as on the 2-weeks

plat, the yields can be increased materially. The 2-weeks plat has every year given the highest net returns, when the cost of irrigation and water are taken into consideration. By the use of 4 acre-inches of water per application on the 2-weeks plat during the years 1915, 1916, and 1917, instead of 5.26 acre-inches as in 1914, the total quantity of water used has been reduced 1.59 acre-feet without reducing the yield, which averaged 5.65 tons per acre when 3.67 acre-feet were applied, as compared with 5.31 tons when 5.26 acre-feet were used. Slightly more hay has been produced on the 1-week plat than on the 2-weeks plat, but the increase over the 2-weeks plat has never been large enough to pay for the additional time required for irrigation and the larger amount of water used.

The average head of water used on these plats in 1917 was 1.38 second-feet, which was not as large a head as is desirable. Economical applications may be made with comparatively small heads of water, but the use of heads ranging from 2 to 4 second-feet results in a great saving of time in irrigation, and most economical applications are usually made with them, because the water receives better attention and because there is less possibility of loss from percolation on account of small heads moving slowly over the land. Closer attention by irrigators to the depth of water they are applying per irrigation would result in a saving of water.

LYSIMETER INVESTIGATIONS.[1]

On the sandy soil of the Umatilla project studies of the rate and amount of percolation and of the character of the percolate are matters of extreme importance. After experiments covering several years in the field relating to quantities of water retained by the soil and lost by percolation, a set of lysimeters or drainage gauges was installed in the spring of 1915 to secure more definite information on the subject.

The lysimeters are concrete pits 3.3 feet square (inside measurement) with a surface area of one four-thousandth of an acre and 6 feet deep. They are constructed of oil-mixed concrete, to make them waterproof, and have funnels extending through the floors to collect the percolate.

The soil was taken from the fields in 6-inch layers and placed in the lysimeters by layers in the original order and as near the original density as possible. The soil placed in lysimeters Nos. 1 to 4 is a medium sand. Lysimeters Nos. 1 to 4 have been operated for three years. Lysimeter No. 1 is not cropped, in order that the evaporation and percolation from the uncropped soil can be ascertained. Lysimeter No. 2 produces a crop of soy beans in the summer and a crop of hairy vetch during the winter, both crops being turned into the soil at maturity to increase the organic-matter and plant-food content of the

[1] This experiment was conducted and reported upon by Mr. H. K. Dean, scientific assistant.

soil. Lysimeter No. 3 grows a crop of alfalfa, which is turned into the soil biennially, a crop of rye during the following winter, which is also turned into the soil, and it is reseeded to alfalfa the following spring. Lysimeter No. 4 grows alfalfa continuously and receives an application of manure at the rate of 32 tons per acre each fall.

In the spring of 1917 four additional lysimeters were installed. Four soil types were placed in them in order to make comparisons with the soil of the old lysimeters and with each other. The soil placed in lysimeter No. 5 is a fine sand. Lysimeter No. 6 has coarse sand. A silt soil was placed in lysimeter No. 7, and a silt loam in lysimeter No. 8.

All lysimeters were irrigated with 2 and 3 inches per application at 6-day intervals except Nos. 5 and 6, which were irrigated with 1½ inches per application at 3-day intervals. Lysimeters Nos. 5 to 8 all grow alfalfa. Some of the more important features of the results obtained in 1917 are indicated in Table XV.

TABLE XV.—*Summary of results obtained for all lysimeters on the Umatilla Experiment Farm in 1917.*

Items of comparison.	Lysimeter number, soil type, and crop.							
	No. 1, medium sand, no crop	No. 2, medium sand, vetch and soy beans.	No. 3, medium sand, rye and alfalfa.	No. 4, medium sand, alfalfa (manured.)	No. 5, fine sand, alfalfa.	No. 6, coarse sand, alfalfa.	No. 7, silt soil, alfalfa.	No. 8, silt loam, alfalfa.
Alfalfa, yield per acre.....tons..	.....	.....	1.99	5.54	1,95	1.19	3.62	3.38
Total water applied.....inches..	62.86	64.86	62.86	62.86	48.76	48.76	47.76	51.76
Percolation:								
Total.....do....	43.006	25.886	17.969	12.023	6.256	14.053	None.	None.
As percentage of application.....	68.4	39.9	28.6	19.1	12.8	28.8	.....	.....
Evaporation-transpiration:								
Total inches.....	19.854	38.973	44.891	50.837	42.504	34.947	48.760	51.760
As percentage of application.....	31.6	60.1	71.4	80.9	87.2	71.2	.....	.....

The figures showing the total water applied represent the irrigation water and the rainfall. The latter amounted to 8.86 inches during the year on lysimeters Nos. 1 to 4 and 3.76 inches from the date lysimeters Nos. 5 to 8 were started to the end of that year. The highest loss from percolation was from lysimeter No. 1, because there was no crop on it. The percolation loss from the lysimeter growing vetch and soy beans was the highest from any lysimeter growing a crop. The percolation loss from the lysimeter which grew rye and first-year alfalfa was slightly higher than from the lysimeter growing old alfalfa. The percolation from the fine-sand lysimeter was 48 per cent less than from the old alfalfa lysimeter, and from the coarse-sand lysimeter 16 per cent more. The percolation from the coarse sand was 111 per cent more than from the fine soil. There was no percolation from the silt-loam lysimeters during the entire season.

The evaporation from the no-crop lysimeter was lower than the evaporation and transpiration from any of the others.

The evaporation and transpiration from the lysimeter growing vetch and soy beans was the lowest in proportion to the water applied of any lysimeter. The proportion of the application lost as transpiration and evaporation by the rye and alfalfa on medium sand was approximately equal to the proportion lost by the lysimeter growing alfalfa on coarse sand. A slightly higher proportion of the application was lost as transpiration and evaporation on the lysimeter containing fine sand with alfalfa than on that containing medium sand with manure. The entire application on the silt and silt-loam lysimeters growing alfalfa was absorbed by the soil and used up as evaporation and transpiration.

During the year 1917 both the irrigation water and the percolate were sampled and tested for total solids, and the following salt constituents were found: Calcium (Ca), carbonates (CO_3), bicarbonates ($HCO)_3$, chlorin (Cl), sulphates (SO_4) and nitrates (NO_3). In no instance was the amount of salt constituents added to the soil by irrigation or leached by percolation sufficiently large to make any material difference in the soil. More calcium was leached from all lysimeters except No. 5 than was added. There was a net loss of carbonates from all lysimeters except from the ones having the fine and coarse sand. More bicarbonates were lost than added to lysimeters Nos. 1 to 3, inclusive, and more added to than lost from lysimeters Nos. 4 to 8. Chlorin represented a net gain to all lysimeters except No. 1. More sulphates were added to all lysimeters by the irrigation water than was lost by percolation. Only traces of nitrates were added by the irrigation water, so there was a loss in the percolate from all lysimeters. The total solids represent a loss in the percolate from all lysimeters. Since there was no percolation from lysimeters Nos. 7 and 8, the amount of salts added by the irrigation water represents net gain.

IRRIGATING STEEP ORCHARD LAND.

Since the beginning of the reclamation work on the experiment farm, one of the most difficult problems has been to irrigate properly the steep lands which occupy a large portion of the area. This was at first attempted by means of small contour furrows. The contour furrows in alfalfa fields were soon abandoned on account of the harmful effects of washing which resulted whenever the water of one furrow broke over into another. The practice was continued in the orchard and vineyard land for six years, though accomplished always with difficulty. Recently a good stand of rye has been established on the steep lands, interspersed with some vetch. With this plant covering, it has been found possible to irrigate by flooding downhill from large contour ditches using a relatively large head of water, all of which was turned out at one place. Field C1, the larger part of which is on steep land, was successfully irrigated in this manner in 1917. The water was applied more evenly and thoroughly and required

much less labor than formerly. This resulted in the saving of water and in the better growth of the trees. The success of this experiment is such as to demonstrate fully that it is possible to irrigate orchard land on steep slopes when there is sufficient vegetation growing to prevent the land from washing. This method of irrigation should make possible the establishment of trees, vines, or bush fruits on some of the steeper lands on the project that are not now being used efficiently. This method appears to be better adapted to orchards and vineyards than to crops other than fruits, since a thick stand of rye and vetch can be maintained under these conditions. Without the thick growth to protect the land, such a method would not be practicable.

FARM DITCH STRUCTURES.

Since it has been positively demonstrated that comparatively large irrigation streams are necessary for economy of water and of time in irrigating, some modification in the size and form of ditch structures

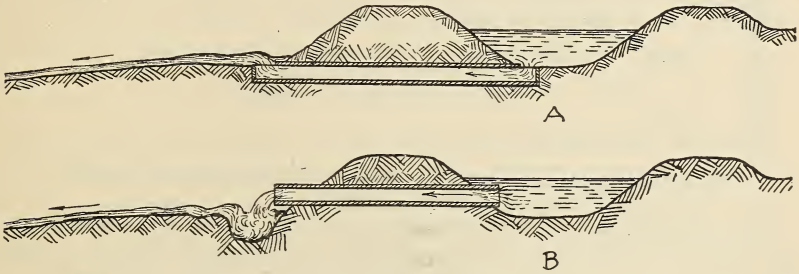

FIG. 2.—Farm ditch structures: *A*, A long siphon box which conveys water from the bottom of the ditch to the surface of the field, thus minimizing the washing of the soil; *B*, a short flood box placed high in the bank of the ditch, whereby a deep hole is washed in the field.

became desirable. It has been observed that on many farms the ditches have been enlarged to twice or three times the original size, as it has been found desirable to increase the head of water to obtain greater efficiency in irrigating. On many farms the irrigation system has not yet been enlarged sufficiently to permit the greatest rapidity in handling water that is necessary to insure a minimum of waste. The same changes that have been made on most farms of this region have been taking place on the experiment farm.

Where 4, 6, and 8 inch flood boxes have been used to carry water through the bank of the ditch in such a manner as to pour it on the field, a siphon box built of the same material and of the same size but longer, located with one end in the bank of the ditch and the other below the ground in the field, permits the water to be handled with a minimum of trouble from leaks and washing. Such a box should be used particularly where the water in the ditch is carried above the land which is to be irrigated. Figure 2, *B*, shows the old flood box, which is usually put through the bank of the ditch near the surface

of the water, the use of which is not recommended. Figure 2, *A*, shows the longer siphon box which can be made to take its place to good advantage.

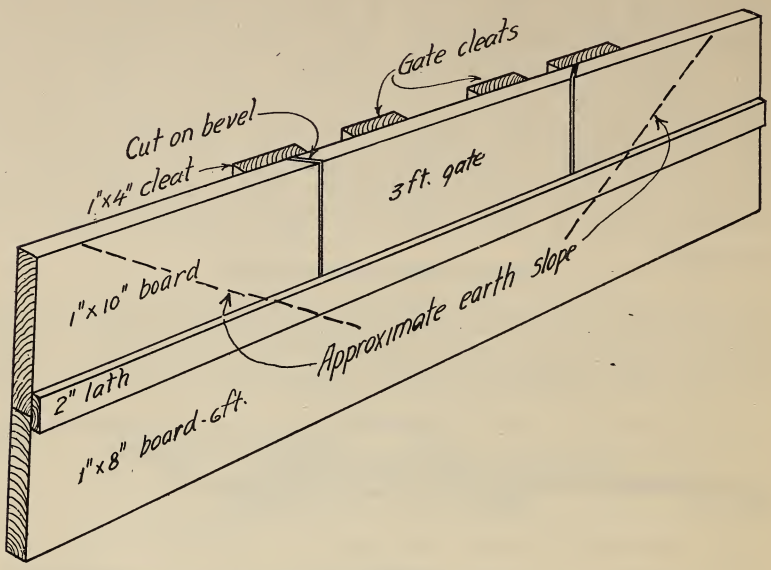

FIG. 3.—Diagram showing the structural details of a wide ditch gate made of lumber.

For all ditches in which the surface of the water is near the same elevation of the land to be irrigated, wide gates are preferable. Forms of gates desirable for these conditions are illustrated in figures 3 and 4. They may be made of 1½ or 2 inch lumber or, preferably, of concrete. One sack of cement will make three of these concrete gates, using a mixture of one part cement to four parts of sand and gravel. In concrete gates flashboards 1 inch thick serve very well. Wooden gates in the same form with an opening 3 feet long require 13 to 18 feet of lumber and can be made in 15 to 20 minutes. These gates should be installed by placing the ridge, or crest, from 2 to 4 inches below the surface of the ground in the border to be irrigated.

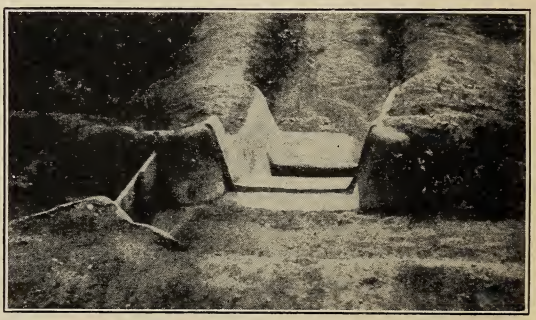

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FIG. 4.—A diversion drop box made of plastered concrete. Wide ditch gates of concrete are made in the same manner, but without the drop.

In this way the water moves out quietly, and very little, if any, waste or erosion results. If the gates are placed high in the bank and the water is permitted to spill over them, they will soon wash out and give trouble. Wooden gates of the type illustrated should be placed in all new ditches, as they can be replaced by concrete gates after the earth settles and becomes firm. The wooden gates can then be taken to newly prepared land and used repeatedly.

Ditch drops and check gates in ditches can now be made with concrete cheaper than with lumber, and the concrete type is decidedly preferable, as there is no leakage if they are properly made. Care should be taken in making such structures to build them of liberal width. The width should be equal to the maximum width of the stream in the ditch. Much washing of drops and check gates results from forcing the water in broad ditches through narrow gates. Numerous forms of ditch structures, including drop boxes, flood boxes, and check gates, have been installed at the experiment farm, where they can be carefully studied by persons who are interested. Figure 4 shows a plastered-concrete diversion and drop box that is very effective and costs less than one made of wood.

VARIETY TESTS OF FRUITS.

The work with varieties of tree fruits and grapes has been continued along the same lines as previously reported except that for the steep portions of the orchard. On this land a change has been made in the method of irrigating, as already noted here, since a good stand of rye and vetch has been established on it.

In 1917 practically all blossoms appeared about two weeks later than in 1916 except on the apricots, which were only 5 to 10 days later. The blossoms appeared this year a month later than in 1914.

Measurements taken to determine the size of trees in 1915 and again in 1917 show that the actual increase has been very slight. This is largely due to the severe weather in 1916, which seriously injured most of the stone fruits, pears, and quinces. The severe pruning in the apple orchard for the purpose of training the trees has prevented a very marked increase in their size.

The conditions surrounding those trees which are situated on the steep land have been very materially improved. This improvement consists in flooding the ground from large contour ditches and frequently cultivating the land close to the trees. The annual crop of vetch and rye is permitted to go to seed and scatter on the ground during the summer. The organic matter derived from these crops and the shade they afford, together with better irrigation, have caused many trees to begin vigorous growth after having struggled along for several years without making an appreciable advance.

APPLES.

In 1916 the average date of blooming was April 22, and in 1917, May 7. The crop of fruit matured about the same time both years. The yield of most varieties was light.

The Banana (*Winter Banana*), Goodwin, Yellow Transparent, and York Imperial produced good yields. In 1916 the Banana, Oldenburg, and Hyslop crab gave the best yields. Of the 47 varieties under observation 31 produced sufficient fruit to permit making detailed notes. The quality of the apples averaged good. In some instances, however, where trees were insufficiently irrigated, the fruit was of inferior quality. It is still too early to make definite recommendations regarding apple varieties, except that the Oldenburg and Yellow Transparent are very satisfactory summer sorts. The Hyslop crab is also very productive. It is difficult to compare the varieties in this experiment, since some trees have had more congenial conditions than others and have grown rapidly. All the apple trees have been hardy and if properly handled, especially by using vetch in the orchard, can be expected to do well on most lands. The poorest results are obtained from trees on heavily graded areas.

PEARS.

Many of the pear trees were severely injured by cold weather in 1916, but have largely recovered. Most of them made a good growth in 1917. Blossoms appeared about two weeks later than the average of three previous years. Only a small number of pears matured, and these were principally Bartlett and Anjou. The fruit ripened at the normal season and was of very good quality. The slow growth which has characterized the pear orchard appears to have been overcome by the establishment of a vetch cover crop and better irrigation methods.

QUINCES.

Two varieties of the quince, the Bourgeat and Rea, have grown very slowly and did not fruit this year. The Angers, Apple, and Smyrna trees have made a fair growth, but produced very little fruit. The Champion and Pineapple appear to be the hardiest trees and bore heavily following a moderate crop last year. It is also observed that the Champion and Pineapple varieties were much less severely injured by cold weather than the others. The trees have made practically no increase in size in the past two years.

PRUNES AND PLUMS.

There is a pronounced difference in the vigor of trees of different varieties of prunes and plums. The Peach and Maynard are very large, and the Sergeant, Golden Drop (*Coe's Golden Drop*), and Agen (*Petite*) are of fair size. It is clear, however, that the size of the

trees is influenced somewhat by soil conditions. The fruit matured 5 to 10 days later than previously. Heavy yields were produced by the Golden Drop, Sergeant, Tragedy, and Lombard. The Sergeant appears to do well even in the poorer soils. It is one of the hardiest trees and produces abundantly.

CHERRIES.

The cherry trees are showing a wide range of adaptability. The sour kinds are much more hardy and tolerant of adverse conditions than the sweet ones. The vigor and growth of the trees vary a great deal. Most varieties produced blossoms, but only a few matured fruit. The blossoms appeared about 15 days later than in 1916, while the fruit matured about the normal time.

APRICOTS.

Apricot blossoms appeared 5 to 10 days later and the fruit matured from the same time to two weeks later than in 1916. The trees were very severely injured by the freeze in 1916. Some of them died during the year and others have almost entirely recovered. The Smyrna and Tilton, both late varieties, produced heavily and from present indications are the best of the 13 varieties in the test.

NECTARINES.

The blossoms and fruit of all varieties of nectarines were later than in previous years. The tree growth is very similar to that of the peach. The crop was light.

PEACHES.

The peach blossoms appeared late, and the fruit of the different varieties matured from two weeks to a month later than in 1916. All but 10 of the 50 varieties produced sufficient fruit to permit notes to be taken.

The Alexander is the first variety to mature and can be used to fair advantage for limited planting; but extensive use of it might render marketing difficult, as the fruit is too soft to ship well. The Triumph is also a good early variety. It matures several days after the Alexander, is much firmer, and has a better flavor. The Dewey (*Admiral Dewey*) is very similar in character and date of maturity to the Triumph. The Columbia is a good early variety, and the trees are hardy and productive. The fruit is large, but is similar in character to the Alexander. The Crosby, Early Crawford, Salwey, and Globe are good late varieties. The Elberta and Perfection are particularly good; the trees are large and strong and the fruit of good size. The Perfection bears very heavily.

Many of the varieties do not promise well, either from lack of vigor of the tree or poor quality or small size of the fruit. This, however, may be due largely to the influence of spotted land or the

vigor of the trees. Table XVI gives the date when blossoms appeared and of the maturity of fruit in 1915 and 1917; also the size of the trees for 1917 and 1915. The slight increase in the size of the trees is largely the result of their being severely frozen in 1916.

TABLE XVI.—*Growth record of peach varieties on the Umatilla Experiment Farm in 1915 and 1917.*

[The freeze of January, 1916, destroyed the fruit buds. Much of the wood of the trees was destroyed, which caused them to be severely cut back. Their size was greatly reduced, but a strong new growth followed.]

Variety.	Date of blossoming.		Date when fruit ripened.		Average size of tree (feet).			
					Height.		Spread.	
	1915	1917	1915	1917	1915	1917	1915	1917
Alexander	Apr. 2	Apr. 19	.....	July 24	6.8	7.3	7.7	9.0
Arp	...do....	Apr. 17	.....	Aug. 4	5.0	5.8	4.0	6.5
Australian Saucer	Apr. 1	.....	.....	.....	7.0	8.1	6.5	6.2
Belle	Mar. 28	Apr. 17	.....	Aug. 27	5.8	7.6	4.0	7.4
Bilyeu	Mar. 26	Apr. 19	.....	.....	8.4	8.6	6.7	8.0
Briggs	Mar. 31	Apr. 20	.....	July 28	8.5	8.9	10.5	10.5
Carman	Mar. 28	Apr. 18	.....	Aug. 17	7.8	5.7	7.5	6.5
Champion	Mar. 29	Apr. 20	.....	Sept. 5	6.5	7.0	6.2	7.3
Chinese Cling	Mar. 28	...do....	.....	Sept. 10	6.8	6.7	5.8	7.8
Columbia	Mar. 26	Apr. 18	.....	Aug. 17	6.3	8.3	6.5	8.7
Crosby	Apr. 2	Apr. 20	Aug. 26	Sept. 12	8.3	8.1	8.7	9.0
Dewey	Mar. 26	Apr. 18	.....	July 31	8.2	7.8	7.8	7.8
Early Crawford	Apr. 4	Apr. 19	.....	Sept. 5	7.0	9.8	7.0	9.7
Early Hale	Mar. 29	...do....	.....	Aug. 17	7.0	7.3	7.1	7.5
Early Imperial	Mar. 26	...do....	.....	Sept. 12	4.5	5.1	3.6	3.1
Elberta	Mar. 29	Apr. 20	Aug. 13	...do....	11.8	10.1	8.2	10.5
Fitzgerald	...do....	...do....	.....	Oct. 5	8.7	8.2	5.3	7.5
Foster	Mar. 30	...do....	.....	.....	5.5	5.5	5.0	4.6
Globe	Mar. 29	...do....	Aug. 2	Sept. 2	11.3	8.3	9.3	10.0
Greensboro	...do....	Apr. 14	.....	July 25	5.2	5.1	5.7	6.2
Heath	...do....	Apr. 20	.....	Sept. 27	7.1	7.4	6.3	7.6
Late Crawford [1]	.....	...do....	.....	Sept. 12	6.3	6.6	4.6	6.4
Late George	Mar. 29	...do....	.....	Oct. 5	9.0	9.2	8.8	8.7
Levis Cling	Mar. 30	...do....	Aug. 26	Sept. 27	5.5	6.7	5.3	7.0
Levy	.....	Apr. 21	.....	.....	6.2	7.2	6.5	7.3
Lovell	Mar. 29	Apr. 20	.....	Sept. 17	6.0	6.2	3.2	5.5
McDevitt	...do....	...do....	.....	Sept. 5	4.8	6.7	3.3	5.1
McKevitt	.....	...do....	.....	Sept. 27	4.0	6.5	2.5	6.3
Morris White	Apr. 2	Apr. 18	.....	Sept. 19	7.2	7.4	5.7	7.2
Mountain Rose	Mar. 29	Apr. 17	.....	Aug. 25	4.2	5.3	3.5	4.7
Muir	...do....	Apr. 20	Aug. 26	Sept. 12	6.3	5.5	4.3	5.1
Opulent	...do....	...do....	Aug. 13	Aug. 27	8.2	7.5	7.8	7.5
Perfection	Apr. 2	...do....	Aug. 26	Sept. 19	9.0	8.6	11.2	11.1
Persian Cling	Mar. 29	Apr. 21	.....	Oct. 5	6.8	6.1	5.2	5.3
Phillips	...do....	...do....	.....	...do....	10.5	10.0	10.0	10.2
Picquet	...do....	Apr. 20	.....	.....	5.0	8.3	4.0	7.3
Runyon	Mar. 27	Apr. 21	.....	Sept. 19	6.5	6.9	6.2	6.1
St. John	Mar. 28	...do....	.....	Aug. 31	5.5	8.1	5.2	7.7
Salwey	Mar. 29	Apr. 20	Sept. 23	Sept. 27	6.7	9.0	7.7	9.0
Sellers	Apr. 2	Apr. 21	Sept. 7	...do....	6.8	6.7	5.5	6.9
Sims Cling	.....	Apr. 18	.....	Sept. 5	5.7	6.7	5.0	6.0
Smock	Mar. 26	Apr. 20	.....	.....	5.1	5.2	5.5	4.0
Sneed	Mar. 29	...do....	.....	.....	4.1	5.7	4.0	5.0
Strawberry	...do....	Apr. 21	.....	Sept. 12	5.3	6.7	7.3	7.4
Susquehanna	.....	...do....	.....	Sept. 23	4.3	6.2	3.1	5.4
Triumph	Mar. 29	Apr. 18	July 15	July 31	6.7	6.8	4.7	6.4
Tuskena	...do....	Apr. 20	.....	Sept. 5	6.2	7.3	6.0	3.2
Van Buren (dwarf)	Mar. 24	.....	Aug. 26	.....	3.2	.....	3.8	.....
Wheatland	Apr. 2	Apr. 21	.....	Sept. 12	8.1	8.0	7.7	7.9
Weber	Mar. 29	Apr. 20	.....	.....	6.7	7.0	5.2	6.0

[1] Not true to name; variety undetermined.

GRAPES.

Many of the grape plants are weak and unthrifty. The cool spring caused them to remain dormant until frosts were past. They grew poorly, blossomed rather indifferently, and produced a very light crop of fruit. The bunches were small and irregular and the

berries mostly undersized, making the yield light. The varieties matured later than usual. Plants in the more exposed portions of the vineyard suffered some injury from the wind.

The vetch sown in the fall of 1916 made a good growth and produced seed enough to establish itself on the ground this year. The Campbell, Diamond, Delaware, Moyer, and Worden grapes showed superior characteristics, as the plants were rather more vigorous and fruitful. The Agawam, Salem, and Brighton plants grew vigorously but produced very little fruit. On account of the demand for Worden grapes by the grape-juice manufacturers this variety is preferred for commercial planting. However, those varieties mentioned as making a desirable showing this year could all be used to advantage for a home supply.

The Vinifera varieties did poorly, making a rather unsatisfactory growth and producing a very light crop of fruit. The vigor of these plants has rapidly declined since their third year. They are not at all adapted to this locality.

ORNAMENTAL AND WINDBREAK PLANTS.

The performance of the various trees and shrubs in the nursery continued about the same as in previous years. The Douglas fir and Rocky Mountain silver cedar are doing better than previously, which is probably due to their better establishment and the increased protection afforded by the trees about them. One tree of Russian oleaster (*Elaeagnus angustifolia*), which differs little, if any, from the others in general appearance, was found to produce fruit larger than that borne by the other trees. This fruit is about five-eighths of an inch in diameter and three-fourths of an inch long.

PASTURE-GRASS VARIETIES.

The importance of pasture for live stock, which should be kept in larger numbers on this project, is beginning to be felt by some farmers. As a result, a demand has arisen for information regarding the best grasses to use in pasture mixtures on this land. To determine the relative value of a number of these grasses, 16 plats were laid out in field A4, each plat 1 rod square. Fourteen kinds of grasses and two species of clover were planted on May 28. The season was late, but fair growth resulted. Table XVII shows the variety of grass used, the character of the seed, and the percentage of germination.

Awnless brome-grass started off well, but soon thinned out until only a few plants remained. It did poorly during the summer, improved somewhat in the fall, but does not look promising.

Chewing's fescue gave only a thin stand of plants, which did not present a vigorous and desirable appearance and gradually disappeared until practically all were gone.

TABLE XVII.—*Varieties of grasses grown and the character of the seed used in a test of pasture grasses on the Umatilla Experiment Farm in 1917.*

Variety.	Kinds of foreign seed present.	Purity and germination tests (per cent).			
		Pure seed.	Inert matter.	Foreign matter.	Seed germinated.
Awnless brome-grass	6	88.30	8.92	2.78	87.50
Chewing's fescue	3	95.24	4.61	.15	12.50
Kentucky bluegrass[1]					
Meadow fescue	13	94.02	4.38	1.60	55.50
Meadow foxtail	11	64.45	29.77	5.78	20.00
English rye-grass	8	97.16	.95	1.89	88.50
Redtop	14	89.86	6.41	3.73	90.75
Do	11	88.54	7.83	3.63	91.00
Rough-stalked meadow fescue	17	85.51	10.99	3.50	11.00
Annual vernal grass	23	82.73	7.02	10.25	55.50
Tall oat-grass	10	88.90	9.82	1.28	59.50
Timothy	4	99.47	.34	.19	95.75
Orchard grass	10	82.76	14.89	2.35	81.50
Western rye-grass	22	86.50	4.28	9.22	9.20
Alsike clover[1]					
White clover[1]					

[1] Neither germination nor purity tests were made of this seed.

Kentucky bluegrass gave a poor stand, which might have been due to the fact that old seed was used. The plants grew rapidly and looked well during the entire season.

Meadow fescue gave a stand of about 50 per cent. The plants grew well and maintained a dark-green color. This is a large, rapid-growing, and very promising grass.

Meadow foxtail started off well and presented a hardy appearance but remained small. It is of doubtful value.

English rye-grass gave a good stand and is a very promising variety. The plants grew vigorously, stooled, and became quite thick. The growth was good during the summer and unusually good in the fall.

Redtop gave a very good stand; the plants grew uniformly but slowly. A few seed stalks appeared late in the summer but did not mature. Growth ceased when the early frosts occurred.

Rough-stalked meadow fescue gave a good stand, but soon died out entirely.

Annual vernal grass gave a good stand, but thinned out until very few plants remained, which were small and unthrifty.

Tall oat-grass produced a fair stand and grew rapidly. It is one of the largest grasses used in the experiment and appears very promising for this district.

Timothy gave a fair stand and is a promising variety; the plants grew vigorously, stooled out, and became large. They were slightly affected by early frosts, but presented a very good appearance.

Orchard grass is large and promising, gave a good stand, and the plants grew rapidly all summer.

Western rye-grass started off by making a very rapid growth and soon began to head out. Heads continued to appear and mature seed until fall. The grass could have been pastured lightly by June 30. At the end of the season the seed stalks appeared to be equal in bulk to the foliage of the plants. The variety made a good late growth and is fairly promising.

Alsike clover planted several days after the grass varieties made good growth, reaching a height of 12 to 16 inches. It produced some seed.

White clover was planted late. The seed was old and a poor stand resulted. The plants grew well and remained green until winter.

From the first year's observations of these grasses on sandy soil, it appears that where the proper varieties are given good care, satis-

FIG. 5.—Plats of grass varieties on the Umatilla Experiment Farm in August, 1917. Navajo corn is hown at the left.

factory pastures may be established. However, it is necessary to have the land well prepared for irrigation, so that they can be watered frequently and evenly. Meadow fescue, English rye-grass, tall oat-grass, timothy, orchard grass, and western rye-grass are promising and worthy of rather extensive trial. Alsike and white clover are well adapted to the soils of this region and can be used in pasture-grass mixtures to good advantage. Figure 5 shows the plats of grass varieties in August.

PRODUCTION OF VETCH SEED IN ORCHARDS.

Following the recommendations in the report on the Umatilla Experiment Farm for 1916, about 10 acres of vetch seed were harvested by one farmer on the project. It was cut either with the mower or scythe and assembled immediately. Two or three rather large stacks were started, and as soon as a layer placed on one of these was cured, it was covered with a layer of green material. In

this way the vetch was handled comparatively green and all the seed that got into the stack was either held in pods or shattered where it could be saved. The success of this practice for harvesting vetch seed has been thoroughly demonstrated in this instance. From 10 acres between orchard trees 2,500 pounds of seed were harvested. It sold at 18 cents per pound and brought a net return of $30 per acre. This represents about one-half the seed produced, as the loss from late harvesting and shattering amounts to about 50 per cent.

Approved:
WM. A. TAYLOR,
Chief of Bureau.

SEPTEMBER 11, 1918.

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